The Effect of the Amount of Corn Used for Ethanol Production on Value Added to the United States Economy by Farmers

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I did not give, receive, or us any unauthorized assistance on this project

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Research Question

What is the effect of the percent of corn use for ethanol production on the total value added to the US economy by farmers?

Introduction

In the recent centuries, ethanol use has skyrocketed in popularity and corn is essential to producing this commodity. Concluding results on if the amount of corn used matters to GDP of farmers opens up insights into future decisions on renewable energy and ethanol use. Ethanol is a renewable energy used for manufacturing and biological purposes. If an increase in ethanol use is bolstering profits for farmers, an increase in ethanol production may have many benefits to all constituents involved. My question attempts to answer if the mechanism behind an increase in overall GDP produced by farmers can be attributed to ethanol production.

Linear Model

$ValueAddedToTheEconomy = \beta_1 PercentCornUsedToProduceEthanol + \beta_2 AverageClosingPriceofCorn + \beta_3 AverageTemperatureUnitedStates + u_i$

ValueAddedtoTheEconomy

This variable captures the total amount of money contributed annually to gross domestic product in the United States by grain crops. This is the category that corn is produced under

PercentCornUsedToProduceEthanol

This variable is simply the annual percent of corn produced used for ethanol production, converted to a number. I expect this to be positive because if more value is being added by corn, increased ethanol production may be a clear indicator as to why it is going up

AverageClosingPriceofCorn

This variable represents the average closing price of a bushel of corn of a year's time span. I expected this variable to be positive because if corn is being used for ethanol, a higher premium may be given to the crop in the market.

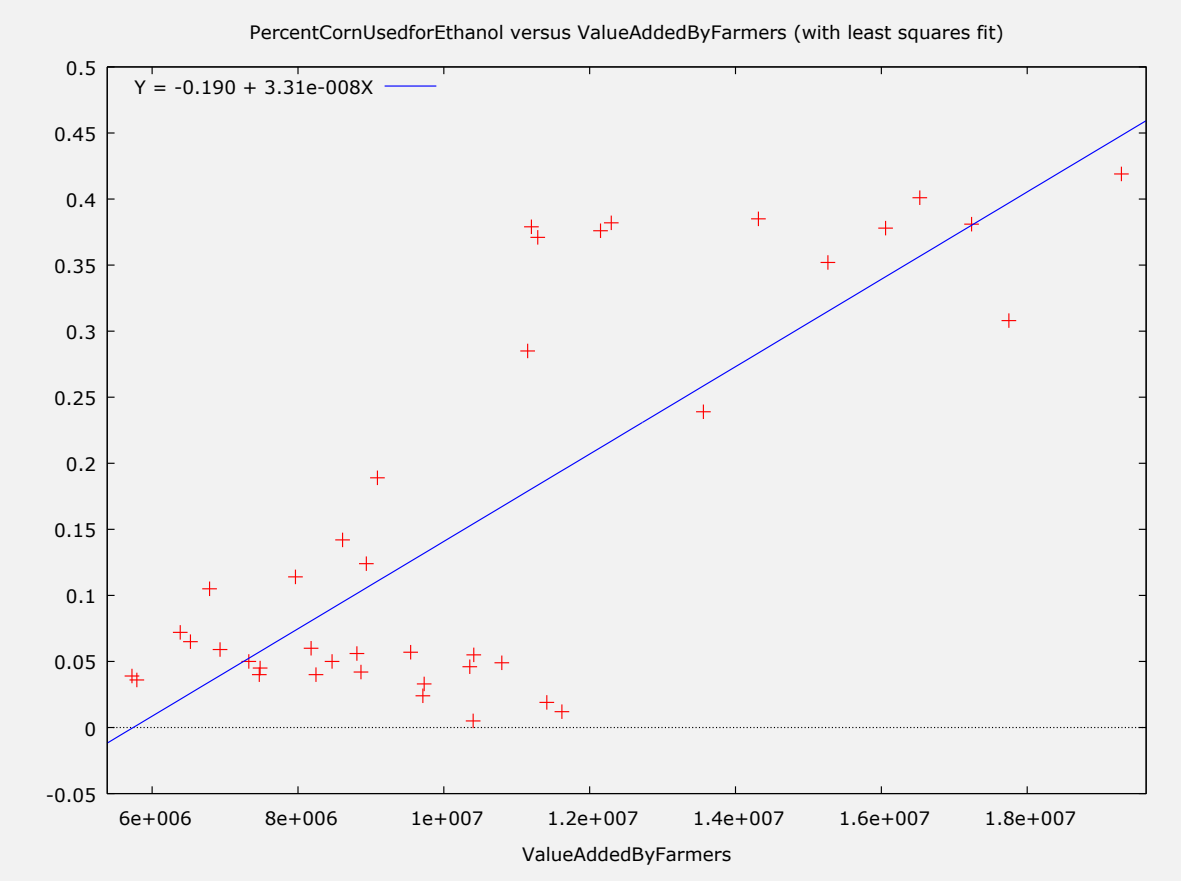
AverageTemperatureUnitedStates

This variable represents the average temperature throughout the whole United States annually. I expect this variable to be positive because higher temperatures make for better growing seasons.

Data Description

The two data sets used were both downloaded from the United States Department of Agriculture website. I then merged them both into my own excel sheet to create my data set for Gretl. The first variable, percent of corn used for ethanol production annually, is measured by percent. The other variable, value added to the economy by farmers annually, is measured in dollars. To input the data into gretl I made the percent values into numbers and kept the other variable the same.

% of corn used to make ethanol:	Value added to the economy:	Average Closing Price of a Bushel of Corn	Average Temperature in the United States
Mean 0.15710	Mean 10492000	Mean 3.2145	Mean 53.019
Minimum 0.0050000	Minimum 9721800	Minimum 1.73	Minimum 51.26
Maximum 0.41900	Maximum 19292000	Maximum 6.91	Maximum 55.32
Standard Deviation 0.14796	Standard Deviation 3464400	Standard Deviation 1.2114	Standard Deviation .96888



Estimation of Linear Model

Model	β	SE(β)	P-value
1.(constant)	7772790	450637	1.45e-019
PercentCornUsedToProduceEthanol	16718400	1891880	1.14e-06
2.(constant)	1844710	797364	0.0264
PercentCornUsedToProduceEthanol	2559490	2293010	0.2715
AverageClosingPriceofCorn	2586760	319350	1.02e-09
3.(constant)	37464700	9384190	0.0003
PercentCornUsedToProduceEthanol	4927400	1660490	0.0053
AverageClosingPriceofCorn	2418010	223510	7.29e-013
AverageTemperatureUnitedStates	-668239	174766	0.0005

Interpretation of Linear Models

First, when examining the first model where the only regressor was PercentCornUsedToProduceEthanol the coefficient on the beta value is 7,772,790. This means that for every 1% increase in the use of corn to produce ethanol there is $7,772,790 of additional money added to the total gross domestic product for grain farmers. The P-value for this model is under .05 which means this is statically significant in a 95% confidence interval. When the regressor AverageClosingPriceofCorn is added the GDP added per 1% increase in the use of corn for ethanol decreases to $2,559,490. This model also displays that for every 1% increase in AverageClosingPriceofCorn there is a $2,586,760 increase in money added to the total gross domestic product for grain farmers. The P-value for PercentCornUsedToProduceEthanol is above .05 which means this is not statically significant in this model, while AverageClosingPriceofCorn has a P-value below .05 which shows this regressor is statically significant. Lastly, the AverageTemperatureUnitedStates regressor is added and its coefficient shows that for every 1% increase in the United States Temperature there is a 668,239 decrease in ValueAddedToTheEconomy. The P-value for this regressor is under .05 which means this regressor is statically significant. When this regressor is added PercentCornUsedToProduceEthanol increases from model 2 to $4,927,400 in model 3. AverageClosingPriceofCorn decreases from model 2 to 2,418,010 in model 3. These 3 models represent that the average closing price of corn is positively associated with ValueAddedToTheEconomy and the average temperature is negatively associated with ValueAddedToTheEconomy.

Nonlinear Model Estimation

Model	β	SE(β)	P-value	SER
(constant)	25547100	27420900	0.3579	1.613360
PercentCornUsedToProduceEthanol	4974100	1729910	0.0068	
AverageClosingPriceofCorn	6150656	7300110	0.4052	
AverageTemperatureUnitedStates	−447346	505209	0.3819	
Interaction between AverageTemperatureUnitedStates and AverageClosingPriceofCorn	−68851.8	133010	0.6080	

R^2: 0.930326

Interpretation of Nonlinear Model

For this model, the regressor the interaction term between AverageClosingPriceofCorn and AverageTemperatureUnitedStates was added to test if these two regressors have a more powerful combined effect. The resulting coefficients shows that a 1% increase in the interaction term causes a decrease of $68,851.8 in ValueAddedToTheEconomy. This means that the two regressors have a weaker combined effect than if they were separate.

Summary

Model 1 shows that the percent corn used to produce ethanol does have a large effect on grain farmers contributed gross domestic product. This is also shown through model 2,3 and the nonlinear model where the coefficient on PercentCornUsedToProduceEthanol continues to stay positive. There were many limitations to my models and studies that could be improved upon in further studies. First, I only used forty years' worth of data because ethanol production did not pick up speed until the 2000's. Adding more years would make the exponential leap in ethanol production seem like a larger effect. Second, the regressor AverageTemperatureUnitedStates was taken across the entirety of the United States. More specific temperature data for states that are the main producers of corn would be a better variable because

a lot of states do not grow corn and therefore, their average temperatures would be irrelevant to the model. Next, ValueAddedToTheEconomy is based on gross domestic product created by grain farmers. This is a problem because grain farmers produce many more crops besides corn. To make this data better I would focus on the states that grow the most amount of corn.

Bibliography

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https://www.ers.usda.gov/data-products/us-bioenergy-statistics/ - TABLE 5

https://www.ncdc.noaa.gov/cag/national/time-series/110/tavg/12/9/1980-2020?base_prd=true&begbaseyear=1901&endbaseyear=2000

https://www.macrotrends.net/2532/corn-prices-historical-chart-data

Appendix

All regressions were run through Gretl using heteroskedastic errors.

Summary statistics, using the observations 1980 - 2019

for the variable 'ofCornusedtomakeehtanol' (40 valid observations)

Mean	0.15710
Median	0.062500
Minimum	0.0050000
Maximum	0.41900
Standard deviation	0.14796
C.V.	0.94183
Skewness	0.70264
Ex. kurtosis	-1.2618
5% percentile	0.012350
95% percentile	0.40020
Interquartile range	0.29825
Missing obs.	0

Summary statistics, using the observations 1980 - 2019

for the variable 'AverageTemparatureinUnitedS' (40 valid observations)

Mean	53.019
Median	52.905

Minimum	51.260
Maximum	55.320
Standard deviation	0.96888
C.V.	0.018274
Skewness	0.49971
Ex. kurtosis	-0.070027
5% percentile	51.394
95% percentile	55.059
Interquartile range	1.2950
Missing obs.	0

Summary statistics, using the observations 1980 - 2019
for the variable 'AverageClosingPriceofCorn' (40 valid observations)

Mean	3.2145
Median	2.7800
Minimum	1.7300
Maximum	6.9100
Standard deviation	1.2114
C.V.	0.37686
Skewness	1.5799
Ex. kurtosis	2.2273
5% percentile	2.0150
95% percentile	6.7445
Interquartile range	1.3300
Missing obs.	0

Summary statistics, using the observations 1980 - 2019
for the variable 'Valueaddedtotheeconomybyf' (40 valid observations)

Mean	1.0492e+007
Median	9.7218e+006
Minimum	5.7234e+006

Maximum	1.9292e+007
Standard deviation	3.4644e+006
C.V.	0.33021
Skewness	0.85684
Ex. kurtosis	-0.028539
5% percentile	5.8199e+006
95% percentile	1.7724e+007
Interquartile range	3.9979e+006
Missing obs.	0

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Missing obs. 0

Model 2: Heteroskedasticity-corrected, using observations 1980-2019 (T = 40)
Dependent variable: Valueaddedtotheeconomybyf

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	7.77279e+06	450637	17.25	<0.0001	***
ofCornusedtomakeehtanol	1.67184e+07	2.89188e+06	5.781	<0.0001	***

Statistics based on the weighted data:

Sum squared resid	89.72621	S.E. of regression	1.536625
R-squared	0.467949	Adjusted R-squared	0.453948
F(1, 38)	33.42174	P-value(F)	1.14e-06
Log-likelihood	−72.91521	Akaike criterion	149.8304
Schwarz criterion	153.2082	Hannan-Quinn	151.0517
rho	0.727499	Durbin-Watson	0.515425

Statistics based on the original data:

Mean dependent var	10491558	S.D. dependent var	3464439
Sum squared resid	1.90e+14	S.E. of regression	2233376

Model 3: Heteroskedasticity-corrected, using observations 1980-2019 (T = 40)
Dependent variable: Valueaddedtotheeconomybyf

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	1.84471e+06	797364	2.314	0.0264	**
ofCornusedtomakeehtanol	2.55949e+06	2.29301e+06	1.116	0.2715	
AverageClosingPriceofCorn	2.58676e+06	319350	8.100	<0.0001	***

Statistics based on the weighted data:

Sum squared resid	133.2086	S.E. of regression	1.897428
R-squared	0.816327	Adjusted R-squared	0.806398
F(2, 37)	82.22234	P-value(F)	2.43e-14
Log-likelihood	−80.81827	Akaike criterion	167.6365
Schwarz criterion	172.7032	Hannan-Quinn	169.4685
rho	0.321457	Durbin-Watson	1.345442

Statistics based on the original data:

Mean dependent var	10491558	S.D. dependent var	3464439
Sum squared resid	7.22e+13	S.E. of regression	1396767

Model 4: Heteroskedasticity-corrected, using observations 1980-2019 (T = 40)
Dependent variable: Valueaddedtotheeconomybyf

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	3.74647e+07	9.38419e+06	3.992	0.0003	***
ofCornusedtomakeethanol	4.92741e+06	1.66049e+06	2.967	0.0053	***
AverageClosingPriceofCorn	2.41801e+06	223510	10.82	<0.0001	***
AverageTemparatureinUnitedS	−668239	174766	−3.824	0.0005	***

Statistics based on the weighted data:

Sum squared resid	99.62024	S.E. of regression	1.663499
R-squared	0.912157	Adjusted R-squared	0.904837
F(3, 36)	124.6079	P-value(F)	4.54e-19
Log-likelihood	−75.00726	Akaike criterion	158.0145
Schwarz criterion	164.7700	Hannan-Quinn	160.4571
rho	0.268966	Durbin-Watson	1.433504

Statistics based on the original data:

Mean dependent var	10491558	S.D. dependent var	3464439
Sum squared resid	6.02e+13	S.E. of regression	1292944

Model 5: Heteroskedasticity-corrected, using observations 1980-2019 (T = 40)
Dependent variable: Valueaddedtotheeconomybyf

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	2.55471e+07	2.74209e+07	0.9317	0.3579	
ofCornusedtomakeethanol	4.97410e+06	1.72991e+06	2.875	0.0068	***
AverageClosingPriceofCorn	6.15065e+06	7.30011e+06	0.8425	0.4052	
AverageTemparatureinUnitedS	−447346	505209	−0.8855	0.3819	
Interaction	−68851.8	133010	−0.5176	0.6080	

Statistics based on the weighted data:

Sum squared resid	91.10257	S.E. of regression	1.613360
R-squared	0.930326	Adjusted R-squared	0.922364
F(4, 35)	116.8357	P-value(F)	9.80e-20
Log-likelihood	−73.21967	Akaike criterion	156.4393
Schwarz criterion	164.8837	Hannan-Quinn	159.4926
rho	0.214453	Durbin-Watson	1.533140

Statistics based on the original data:

Mean dependent var	10491558	S.D. dependent var	3464439
Sum squared resid	6.24e+13	S.E. of regression	1334786